the mutual gravitational attraction of two bodies whose mass distributions are symmetrical with respect to the same axis, deals with certain problems in the theory of Attraction which, although fairly accessible to treatment, seem to have been overlooked (some of the equations occur in Todhunter, "History of the Theories of Attraction and Figure of the Earth," vol. ii. p. 102).—A paper by Prof. Roe, on symmetric functions, considers the matter from two standpoints. The first part deals with the functions as a whole, and is mainly critical and historical. Part ii. treats of the individual terms of a symmetric function, together with their coefficients. Prof. Chessin applies the theory (which we have noted in the abstract of a paper previously read by him) to the problem of three bodies m_1, m_2, m_3, viz. when the mass of one of them (m_3) is infinitely small compared with the masses m_1 and m_2, while the eccentricity of the orbits of m_1 and m_2 is zero, so that these bodies move uniformly in concentric circles above their common centre of gravity. Such is very nearly the case of a small planet in the presence of the sun and Jupiter, and also very approximately the case of satellites.—Prof. Lovett's contact transformations of developable surfaces discusses the determination of the contact transformations which leave invariant the partial differential equation $| p_{11}, p_{22}, \ldots, p_{nn} | = 0$ (*cf.* Lie, Darboux and Mayer. Some of the results are complete generalisations of those of a memoir of G. Vivanti, *Rend. di Circ. Mat. di Palermo*, vol. v. 1891).—Concerning a linear homogeneous group in $C_{m,q}$ variables isomorphic to the general linear homogeneous group in m variables, is a paper which was read by Dr. L. E. Dickson at the August meeting. It is chiefly concerned with continuous groups, but its results are readily utilised for discontinuous groups. An analogous isomorphism is discussed in a paper presented recently to the London Mathematical Society.—A second locus connected with a system of coaxial circles, by Prof. T. F. Holgate, read at the same meeting, is a very interesting extension of a paper, by the same author, which was communicated to the Toronto meeting, November 1897.—Prof. Emch, of Biel, Switzerland, communicates a note, entitled "Reciprocal transformations of projective coordinates and the theorems of Ceva and Menelaos." The note is illustrated with diagrams. The author confines himself to the two above-named theorems and their connection with certain transformations of plane and space. The properties admit of multiplication, some of which have been discussed by Rosace and Steiner.—The "notes," as usual, contain a good deal of information useful to mathematical students.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 15, 1898.—"Note on the Densities of 'Atmospheric Nitrogen,' Pure Nitrogen, and Argon." By William Ramsay, F.R.S.

It is concluded that the density of "atmospheric" nitrogen is correctly given as the mean of the densities of the constituents, taken in the proportion in which they occur.

Chemical Society, Dec. 15, 1898.—Prof. Dewar, President, in the chair.—The following papers were read.—The interaction of ethylic sodiomalonate and mesityl oxide, by A. W. Crossley. Mesityl oxide and ethylic sodiomalonate do not condense in the expected manner, but the product on hydrolysis yields a diabasic acid, $C_{16}H_{24}O_4$ melting at 148–148°·5; derivatives of this acid are described.—The interaction of ethylic malonate and acetylene tetrabromide in presence of sodium ethoxide, by A. W. Crossley. Ethylic disodiomalonate and acetylene tetrabromide react with evolution of acetylene and formation of tribromethylene and tetrethylic acetylenetetracarboxylate.—Derivatives of camphoric acid: Part iii., by F. S. Kipping. A number of compounds obtained from π-bromocamphoric acid are described.—Synthesis of αββ-trimethylglutaric acid, by W. H. Perkin, jun., and J. F. Thorpe. Ethylic sodio-α-cyano-ββ-dimethylglutarate is obtained by the interaction of ethylic cyanacetate, ethylic dimethylacrylate and sodium ethoxide; methylic iodide converts it into ethylic α-cyano-αββ-trimethylglutarate which on hydrolysis gives αββ-trimethylglutarimide. This imide yields αββ-trimethylglutaric acid, $COOH.CHMe.CMe_2.CH_2.COOH$, when heated with hydrochloric acid.—Hydrolysis of methylic and ethylic γ-cyanoacetoacetates and their derivatives, Part i., by W. F. Lawrence. Methylic γ-cyanodimethylacetoacetate is hydrolysed by hydrochloric acid with formation of αα-dimethyl-β-hydroxyglutaconic acid, $COOH.CH : C(OH).CMe_2.COOH$; this, on reduction with hydriodic acid, yields αα-dimethylglutaconic acid.

Geological Society, December 21, 1898.—W. Whitaker, F.R.S., President, in the chair.—On a Megalosauroid jaw from Rhætic beds near Bridgend, Glamorganshire, by E. T. Newton, F.R.S. The specimen which forms the subject of this communication was obtained by Mr. John David of Porthcawl, and it has been presented to the Museum of Practical Geology. It was derived from beds low down in the Rhætic series, which may eventually have to be included in the upper part of the Keuper. The specimen does not admit of exact comparison with *Megalosaurus*, and it is named as a new species of *Zanclodon*—a genus in which the author is also inclined to place some forms described under the names of *Palaeosaurus*, *Cladyodon*, *Avalonia*, and *Picrodon*.—The torsion-structure of the Dolomites, by Maria M. Ogilvie [Mrs. Gordon]. The paper opens with a general account of the work of Richthofen, Mojsisovics, Rothpletz, Salomon, Brögger, the author, and others on the Dolomitic area of Southern Tyrol. It then gives the results of a detailed survey recently made by the author of the complicated stratigraphy of the rocks of the Gröden Pass, the Buchenstein Valley, and the massives of Sella and Sett Sass; together with the author's interpretation of these results, and her application of that interpretation to the explanation of the Dolomite region in general. The author concludes that overthrusts and faults of all types are far more common in the Dolomites than has hitherto been supposed. The arrangement of these faults is typically a *torsion*-phenomenon, the result of the superposition of a later upon an earlier strike. This later crust-movement was of Middle Tertiary age, and one with the movement which gave origin to the well-known Judicarian-Asta phenomena. The youngest dykes (and also the granite-masses) are of Middle Tertiary age, while the geographical position of both is the natural effect of the crust-torsion itself. This crust-torsion also fully explains the peculiar stratigraphical phenomena in the Dolomite region, such as the present isolation of the mountain-massives of dolomitic rock. After discussing in detail the structure of various areas, the author applies her results to the interpretation of the complexities of the Judicarian-Asta region of the Dolomites in general, and also to the explanation of the characteristic structural forms of the Alpine system as a whole.

Royal Microscopical Society, December 21, 1898.—Mr. E. M. Nelson, President, in the chair.—The President exhibited a new objective by Carl Zeiss, called a "Plankton-searcher," a low power water immersion objective, designed for use in examining living objects in water, the definition of which was exceedingly sharp. He also exhibited an erecting eye-piece fitted with Porro's prisms, another new appliance produced by the same firm, which would be found useful for dissecting and other purposes.—Mr. Keith Lucas exhibited and described a new model microscope, the design of which was to effect the coarse and fine adjustments by means of a single slide, thereby reducing the expensive work of planing.—The President directed attention to some of the various types of binocular microscopes that were exhibited: among those referred to were Ahrens' binocular eye-piece, in which both tubes were equally inclined, and a microscope by Murray and Heath, one tube only being inclined, the other lying in the optical axis of the instrument, the construction being similar to that of Nachet; these two instruments were exhibited by the Society.—There was a new binocular dissecting microscope by Leitz, exhibited by Messrs. Watson and Sons, consisting of two Brücke lenses fitted on a bar by jointed attachments so that the distance between the tubes could be adjusted to suit the eyes. This was likely to prove valuable for examination of objects, or for dissection under low power.—Attention was directed also to a form exhibited by Carl Zeiss, made with Porro's prisms, giving an erect image; this microscope is provided with two objectives of equal power, one for each tube, the stereoscopic effect being greater than that obtained by a divided image from one objective.—Messrs. Powell and Lealand exhibited their high-power binocular prism in conjunction with a 1/20-inch apochromatic objective.—A Mojinie's portable binocular, a Nelson model, Wenham's binocular with a high power objective, a binocular microspectroscope, were exhibited, besides various patterns of Stephenson and Wenham binocular microscopes by Messrs. Chas. Baker, R. and J. Beck,

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J. Pillischer, Swift and Son, and Watson and Sons.—Among the other objects exhibited may be mentioned typical species of Foraminifera selected from various localities by Mr. A. Earland, which were rare and beautiful; and mounted specimens of Hydrozoa, by Mr. G. E. Harris.

EDINBURGH.

Royal Society, December 19.—Lord Kelvin in the chair.—Mr. R. G. Alford read a paper on crane scaffoldings, their mathematical calculations and probable theoretical deficiencies. The paper was a comparison of two similar scaffoldings, one of which was overturned in a gale which the other resisted.—In a note on dew bows, Drs. Knott and Lundie gave an account of a system of brilliant "bows" produced at night on the ground, the source of light being the gas-lamp or electric light of the street. The phenomenon required the existence on the ground of a layer of numerous globules of water of nearly the same size and so small as to suffer little distortion from perfect sphericity. The globules were fog particles, which had gradually settled down in the still air of the last of four days of heavy fog. The curves formed by these dew bows are plane sections of a toroidal surface. Some of the curves were drawn on a black board by means of a simple but obvious kinematical model.—Lord Kelvin communicated a paper on the reflection and refraction of solitary plane waves at a plane interface between two isotropic elastic mediums, fluid, solid, or ether. The investigation presented certain novelties of treatment. One of these was the introduction of the condensational-rarefactional waves of reflection and refraction moving with slow velocities through the (contractile) ethers. (The *four* waves into which a wave of either type breaks up at the boundary of two elastic solids were first discussed by Knott in 1888, with special reference to earthquake waves.) Then there was the question of the total reflection of a solitary wave instead of a train of waves. And finally there was the application of the principle of the continuity of the rotational magnetic force at the interface. Fresnel's *sine* and *tangent* formulæ for the reflection of plane polarised rays followed at once.—Mr. Sydney A. Kay communicated a paper on the equilibrium between sulphuric acids and sulphates in aqueous solutions. The concentrations of the free acid, neutral sulphate, and acid sulphate in solutions containing sulphuric acid and a neutral sulphate were determined by means of a reaction velocity method—namely, by the catalysis of ethylic acetate. Then the degrees of dissociation in the three substances were calculated from Kohlrausch's later determinations of the electric conductivities at infinite dilution. Finally an expression for the equilibrium was developed as an empirical formula which, within the limits of the experiments, gave results in close agreement with observation. The formula was

$$\frac{\{\text{Conc. } H_2SO_4(1-\alpha_1)\}^{0{\cdot}85}}{\text{Conc. } MHSO_4(1-\alpha_3)}=\frac{A}{\{\text{Conc. } M_2SO_4(1-\alpha_2)\}^x}$$

where conc. means concentration, M is the symbol for the metal involved, α_1 α_2 α_3 are the degrees of dissociation, A and x are constants with characteristic values for each case. Thus, when M is potassium, sodium or lithium, A has corresponding values 0·259, 0·0618, or 0·0600 respectively, and x has values 1, 1·35, 1·35 respectively.—Mr. David Robertson read a paper on dust figures of electrostatic lines of force. These were obtained by sprinkling the dust over a glass plate against the under surface of which were pressed electrodes in connection with a Wimshurst machine. The chief difficulty was to get a suitable substance; for the particles should be sufficiently conducting to be acted on inductively, and yet sufficiently insulating to prevent escape of the charges. Of the many kinds of dust tried, pure mahogany sawdust coloured with ink was found to be the most efficient. It was stated that the secret of getting good results lay in stopping the action of the machine at the right moment. Many interesting examples of the curves were exhibited.—In a note on the action of persulpates on iodine, Dr. Hugh Marshall drew attention to a reaction which seems to have been neglected by recent experimenters. When, for example, a solution of potassium iodide is being boiled with ammonium persulphate so as to decompose it and drive off the iodine by sublimation, the iodine in the liquid seems to disappear at a more rapid rate than corresponds to the amount volatilised. In fact, as was proved by direct experiment, the iodine is oxidised by the persulphate, and becomes iodic acid.—A paper by Prof. Anglin, on the summation of the series whose nth terms are u_n and $1/u_n$ where u_n denotes

$$(an+b)\{a(n+1)+b\}\{a(n+2)+b\}\ldots\{a(n+r-1)+b\}$$

was also read.

PARIS.

Academy of Sciences, January 2.—M. van Tieghem in the chair.—On the estimation of phosphorus and sulphur in plants and their ashes, by M. Berthelot. Of the various methods suggested for determining sulphur and phosphorus in plants, burning in a stream of oxygen, and subsequently passing the gases over a long column of red-hot sodium carbonate, gave the highest results. Prolonged boiling with strong nitric acid or estimation after incineration showed large deficiencies in both sulphur and phosphorus.—On the presence and estimation of chlorine in plants, by M. Berthelot. Combustion with oxygen in presence of sodium carbonate gave higher results than a careful incineration in the ordinary way. An attempt was made to distinguish between the total chlorine and the chlorine existing in the plant in the form of chlorides, but without much success.—Preparation and properties of an organic ammonium, lithium—monomethylammonium, by M. Henri Moissan. Anhydrous methylamine reacts vigorously with lithium at temperatures near 0° C., forming a blue solution similar to the alkaline ammoniums. The composition approximated to $Li(CH_3.NH_2)$. In a vacuum this loses methylamine, and finally deposits brilliant crystals of metallic lithium, no gas being evolved.—Influences of metallic armatures upon the properties of mortars, by M. Considère.—Constitution of the ring of small planets, by M. Jean Mascart. Curves are given showing the distribution of longitudes of the nodes and perihelia of the asteroids for every 30°.—Observation of the total eclipse of the moon of December 27, 1898, made at the Observatory of Lyons, by M. Ch. André. The state of the sky interfered considerably with the observations.—Observations made at the Observatory of Toulouse during the eclipse of December 27, 1898, by MM. Baillaud, Bourget, Montangerand, Rossard, and Besson, by M. Baillaud. Ten photographs were successfully taken during the eclipse.—Observations of the Brooks comet (October 1898) and Chase comet, made at the Observatory of Toulouse with the Brunner equatorial, by M. F. Rossard.—On the propagation of liquid waves through water, by M. Georges Poisson.—On the absorption of light by a body placed in a magnetic field, by M. Auguste Righi. When such gases as nitrogen peroxide, iodine, iodine monobromide, iodine monochloride, or selenium tetrabromide of suitable concentration are placed in the path of a ray of light in a strong magnetic field, a distinct change in the colour of the transmitted light is noticeable when the electromagnetic circuit is completed.—On a simple form of magnetometer, by M. A. Guillet. Two diagrams of the apparatus are given, together with the theory of the instrument, but no actual measurements are cited.—General method of separation of chlorine, bromine and iodine in the form of silver salts, by M. H. Baubigny. The dry silver salts are treated with sulphuric acid containing bichromate, the chlorine and bromine distilled off into potash containing sulphite, and these separated by the use of potassium permanganate and copper sulphate. The two test analyses given are very satisfactory.—On the formation of the head of the Hymenoptera, by M. L. G. Seurat. The head is formed uniquely from the head of the larva; at first invaginated, this head, by a movement of rotation in the median plane, becomes devaginated and acquires its final form.—A transverse section of the Briançon Alps, from Gironde to the Italian frontier, by MM. Kilian and Lugeon.—Ostioles in the animal and vegetable kingdoms considered as a regulating apparatus, by M. J. J. Andler.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 12.

MATHEMATICAL SOCIETY, at 8.—On a Determinant each of whose Elements is the product of k Factors: Prof. W. H. Metzler.—Properties of Hyper-space, in relation to Systems of Forces, the Kinematics of Rigid Bodies, and Clifford's Parallels: A. N. Whitehead.—A Simple Method of Factorising Large Composite Numbers of any unknown form: D. Biddle.—Zeroes of the Bessel Functions (second paper): H. M. Macdonald.—Linear Substitutions and Inversions: Dr. G. G. Morrice.—On the Reduction of a Linear Substitution to its Canonical Form: Prof. Burnside, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

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